[0013] These and other features, aspects and advantages of various embodiments will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the present disclosure and, together with the description, serve to explain the related principles.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Detailed discussion of embodiments directed to one of ordinary skill in the art are set forth in the specification, which makes reference to the appended figures, in which:

[0015] FIG. **1** depicts a perspective view of an example wind turbine according to example embodiments of the present disclosure;

[0016] FIG. **2** depicts an internal view of an example nacelle of a wind turbine according to example embodiments of the present disclosure;

[0017] FIG. **3** depicts an overview of an example pitch angle adjustment motor control system according to example embodiments of the present disclosure;

[0018] FIG. **4** depicts a block diagram of an example controller according to example embodiments of the present disclosure;

[0019] FIG. **5** depicts an overview of an example pre-charge control system for a capacitor bank according to example embodiments of the present disclosure;

[0020] FIG. **6** depicts a plot of an example charge current applied to a capacitor bank according to example embodiments of the present disclosure; and

[0021] FIG. **7** depicts a flow diagram of an example method of pre-charging a capacitor bank according to example embodiments of the present disclosure.

DETAILED DESCRIPTION OF THE INVENTION

[0022] Reference now will be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

[0023] Example aspects of the present disclosure are directed to systems and methods of pre-charging a capacitor bank. For instance, a power switch and a current limiting device, such as an inductor device, can be coupled between a DC power source and a capacitor bank comprising one or more capacitor devices. Operation of the power switch can be controlled to limit the magnitude of a peak amount of charging current flowing through the current limiting device and into the capacitor bank. When the voltage at the capacitor bank reaches a threshold voltage level, the pre-charging process can be ceased. In this manner, a bypass contactor can be positioned such that, when the bypass contactor is closed, current does not flow through the pre-charging circuit (e.g. the power switch and the current limiting device).

[0024] More particularly, the power switch can be a pulse width modulation (PWM) controlled power switch, such as a metal-oxide-semiconductor field-effect transistor (MOSFET), IGBT, one or more contactors, a power relay, or other power switch. The current limiting device can be an inductor device. One or more control devices can drive power switch the gate of the MOSFET based at least in part on the magnitude of the current applied to the inductor. For instance, in embodiments wherein the power switch is a MOSFET, the one or more control devices can drive the gate of the MOSFET based at least in part on the magnitude of the current applied to the inductor. A current sensing device, such as a resistor, current transformer, current transducer, Hall-effect device, or other current sensing device can be coupled in series between the MOSFET and the inductor. The current sensing device can be configured to sense the current applied to the inductor and to provide a signal indicative of the magnitude of the current to the gate driving control device.

[0025] As indicated above, the gate driving control device can be configured to drive the gate of the MOSFET using PWM techniques. In this manner, the gate driving control device can be configured to adjust the duty cycle of the signal provided to the gate of the MOSFET based at least in part on the signal indicative of the magnitude of the current. As used herein, a duty cycle is a ratio between the duration that a signal pulse is in the active (e.g. high) state to the total modulation period of the signal. In particular, for each modulation period of the signal pulse, the gate driving control device can be configured to drive the signal pulse low when the sensed current reaches a current threshold, thereby turning the power switch off. In example embodiments, the current threshold can be between about 0.7 amperes and about 1.5 amperes. As used herein, the term "about," when used in conjunction with a numerical value is intended to refer to within 30% of the stated numerical value. When the power switch is turned off, current will not flow into the current limiting device. In this manner, at the start of the immediately subsequent modulation period, the signal pulse can be driven high, thereby turning the power switch on. With the power switch turned on, the current flowing through the current limiting device to the capacitor bank will begin to increase. When the current again reaches the current threshold, the signal pulse can be driven low, thereby turning the power switch off

[0026] Throughout the pre-charging process, the voltage at the capacitor bank will increase. Such voltage at the capacitor bank can be monitored. The pre-charging process can be ceased when the voltage at the capacitor bank reaches a voltage threshold value. For instance, the voltage threshold value can be between about 60% and about 95% of the DC input voltage. In this manner, when the measured voltage at the capacitor bank reaches the threshold voltage value, a bypass contactor can be closed, such that current does not flow through the current limiting device.

[0027] With reference now to the figures, example embodiments of the present disclosure will be discussed in further detail. For instance, FIG. **1** depicts a perspective view of one embodiment of a wind turbine **10**. As shown, the wind turbine **10** generally includes a tower **12** extending from a support surface **14**, a nacelle **16** mounted on the tower **12**, and a rotor **18** coupled to the nacelle **16**. The rotor **18**